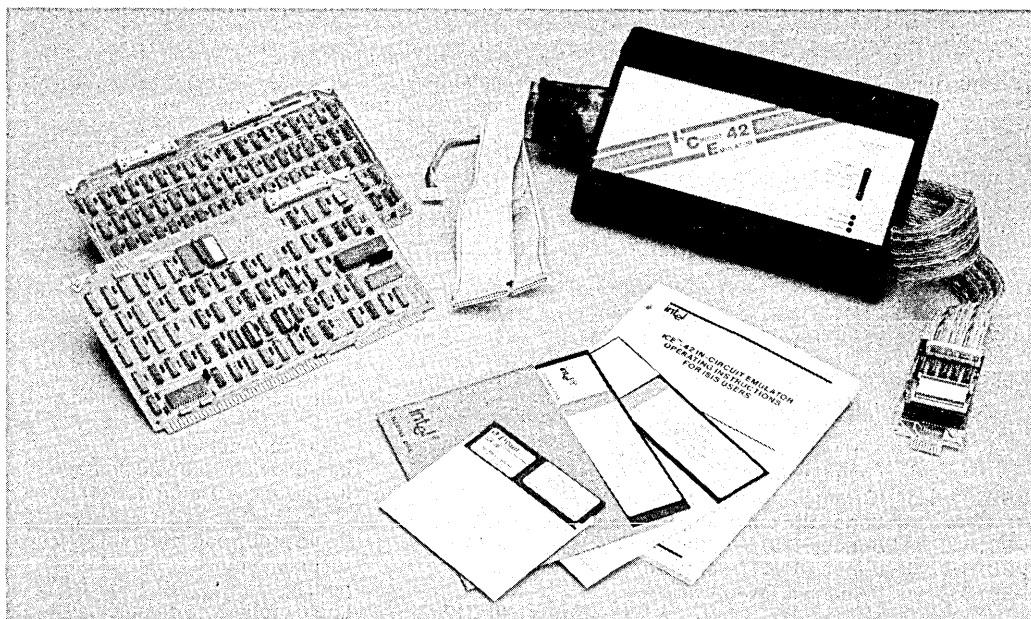




ICE™-42 8042 IN-CIRCUIT EMULATOR

- **Precise, full-speed, real-time emulation**
 - Load, drive, timing characteristics
 - Full-speed program RAM
 - Parallel ports
 - Data Bus
- **User-specified breakpoints**
- **Execution trace**
 - User-specified qualifier registers
 - Conditional trigger
 - Symbolic groupings and display
 - Instruction and frame modes
- **Emulation timer**
- **Full symbolic debugging**
- **Single-line assembly and disassembly for program instruction changes**
- **Macro commands and conditional block constructs for automated debugging sessions**
- **HELP facility: ICETM-42 command syntax reference at the console**
- **User confidence test of ICETM-42 hardware**

The ICETM-42 module resides in the Intellec Microcomputer Development System and interfaces to any user-designed 8042 or 8041A system through a cable terminating in an 8042 emulator microprocessor and a pin-compatible plug. The emulator processor, together with 2K bytes of user program RAM located in the ICE-42 buffer box, replaces the 8042 device in the user system while maintaining the 8042 electrical and timing characteristics. Powerful Intellec debugging functions are thus extended into the user system. Using the ICE-42 module, the designer can emulate the system's 8042 chip in real-time or single-step mode. Breakpoints allow the user to stop emulation on user-specified conditions, and a trace qualifier feature allows the conditional collection of 1000 frames of trace data. Using the single-line 8042 assembler the user may alter program memory using the 8042 assembler mnemonics and symbolic references, without leaving the emulator environment. Frequently used command sequences can be combined into compound commands and identified as macros with user-defined names.



FUNCTIONAL DESCRIPTION

Integrated Hardware and Software Development

The ICE-42 emulator allows hardware and software development to proceed interactively. This approach is more effective than the traditional method of independent hardware and software development followed by system integration. With the ICE-42 module, prototype hardware can be added to the system as it is designed. Software and hardware integration occurs while the product is being developed. Figure 1 shows the ICE-42 emulator connected to a user prototype.

The ICE-42 emulator assists four stages of development:

SOFTWARE DEBUGGING

This emulator operates without being connected to the user's system before any of the user's hardware is available. In this stage ICE-42 debugging capabilities can be used in conjunction with the Intellec text editor and 8042 macro-assembler to facilitate program development.

HARDWARE DEVELOPMENT

The ICE-42 module's precise emulation characteristics and full-speed program RAM make it a valuable tool for debugging hardware.

SYSTEM INTEGRATION

Integration of software and hardware begins when any functional element of the user system hardware is connected to the 8042 socket. As each section of the user's hardware is completed, it is added to the prototype. Thus, each section of the hardware and software is "system" tested in real-time operation as it becomes available.

SYSTEM TEST

When the user's prototype is complete, it is tested with the final version of the user system software. The ICE-42 module is then used for real-time emulation of the 8042 chip to debug the system as a completed unit.

The final product verification test may be performed using the 8742 EPROM version of the

8042 microcomputer. Thus, the ICE-42 module provides the ability to debug a prototype or production system at any stage in its development without introducing extraneous hardware or software test tools.

Symbolic Debugging

The ICE-42 emulator permits the user to define and to use symbolic, rather than absolute, references to program and data memory addresses. Thus, there is no need to recall or look up the addresses of key locations in the program, or to become involved with machine code.

When a symbol is used for memory reference in an ICE-42 emulator command, the emulator supplies the corresponding location as stored in the ICE-42 emulator symbol table. This table can be loaded with the symbol table produced by the assembler during application program assembly. The user obtains the symbol table during software preparation simply by using the "DEBUG" switch in the 8042 macroassembler. Furthermore, the user interactively modifies the emulator symbol table by adding new symbols or changing or deleting old ones. This feature provides great flexibility in debugging and minimizes the need to work with hexadecimal values.

Through symbolic references in combination with other features of the emulator, the user can easily:

- Interpret the results of emulation activity collected during trace.
- Disassemble program memory to mnemonics, or assemble mnemonic instructions to executable code.
- Reference labels or addresses defined in a user program.

Automated Debugging and Testing

MACRO COMMAND

A macro is a set of commands given a name. A group of commands executed frequently can be defined as a macro. The user executes the group of commands by typing a colon followed by the macro name. Up to ten parameters may be passed to the macro.

Macro commands can be defined at the beginning of a debug session and then used throughout the whole session. One or more macro definitions can be saved on diskette for later use. The Intellec text editor may be used to edit the macro file. The macro definitions are easy to include in any later emulation session.

The power of the development system can be applied to manufacturing testing as well as development by writing test sequences as macros. The macros are stored on diskettes for use during system test.

COMPOUND COMMAND

Compound commands provide conditional execution of commands (IF command) and execution of commands repeatedly until certain conditions are met (COUNT, REPEAT commands).

Compound commands may be nested any number of times, and may be used in macro commands.

Example:

```
*DEFINE .I=0      ; Define symbol .I to 0
*COUNT 100H      ; Repeat the following
                  ; commands 100H times.
.*IF .I AND 1 THEN ; Check if .I is odd
..*CBYTE.I=.I      ; Fill the memory at
                  ; location .I to value .I
..*END
.*I-.I+1           ; Increment .I by 1.
.*END             ; Command executes
                  ; upon carriage-return
                  ; after END
```

(The asterisks are system prompts; the dots indicate the nesting level of compound commands.)

Operating Modes

The ICE-42 software is an Intellec RAM-based program that provides easy-to-use commands for initiating emulation, defining breakpoints, controlling trace data collection, and displaying and controlling system parameters. ICE-42 commands are configured with a broad range of modifiers that provide maximum flexibility in describing the operation to be performed.

EMULATION

The ICE-42 module can emulate the operation of prototype 8042 system, at real-time speed (up to 12MHz) or in single steps. Emulation commands to the ICE-42 module control the process of setting up, running, and halting an emulation of the user's 8042-based system. Breakpoints and tracepoints enable the ICE-42 emulator to halt emulation and provide a detailed trace of execution in any part of the user's program. A summary of the emulation commands is shown in Table 1.

Table 1 Major Emulation Commands

Command	Description
GO	Begins real-time emulation and optionally specifies break conditions.
BR0, BR1, BR	Sets or displays either or both Breakpoint Registers used for stopping real-time emulation.
STEP	Performs single-step emulation.
QR0, QR1	Specifies match conditions for qualified trace.
TR	Specifies or displays trace-data collection conditions and optionally sets Qualifier Register (QR0, QR1).
Synchronization Line Commands	Sets and displays status of synchronization line outputs or latched inputs. Used to allow real-time emulation or trace to start and stop synchronously with external events.

Breakpoints

The ICE-42 hardware includes two breakpoint registers that allow halting of emulation when specified conditions are met. The emulator continuously compares the values stored in the breakpoint registers with the status of specified address, opcode, operand, or port values, and halts emulation when this comparison is satisfied. When an instruction initiates a break, that instruction is executed completely before the break takes place. The ICE-42 emulator then regains control of the console and enters the interrogation mode. With the breakpoint feature, the user can request an emulation break when the program:

- Executes an instruction at a specific address or within a range of addresses.

- Executes a particular opcode.
- Receives a specific signal on a port pin.
- Fetches a particular operand from the user program memory.
- Fetches an operand from a specific address in program memory.

Trace and Tracepoints

Tracing is used with real-time and single-step emulation to record diagnostic information in the trace buffer as a program is executed. The information collected includes opcodes executed, port values, and memory addresses. The ICE-42 emulator collects 1000 frames of trace data.

If desired this information can be displayed as assembler instruction mnemonics for analysis during interrogation or single-step mode. The trace-collection facility may be set to run condi-

tionally or unconditionally. Two unique trace qualifier registers, specified in the same way as breakpoint registers, govern conditional trace activity. The qualifiers can be used to condition trace data collection to take place as follows:

- Under all conditions (forever).
- Only while the trace qualifier is satisfied.
- For the frames or instructions preceding the time when a trace qualifier is first satisfied (pre-trigger trace).
- For the frames or instructions after a trace qualifier is first satisfied (post-triggered trace).

Table 2 shows an example of trace display.

INTERROGATION AND UTILITY

Interrogation and utility commands give convenient access to detailed information about the

Table 2 Trace Display (Instruction Mode)

FRAME	LOC	OBJ	INSTRUCTION	P1	P2	TO	TL	DBYIN	YOUT	YSTS	TOVF
0000:	100H	2355	MOV A,#55H	FFH	FFH	0	0	66H	DFH	02H	0
0004:	102H	39	OUTL P1,A	FFH	FFH	0	0	66H	DFH	02H	0
0008:	103H	3A	OUTL P2,A	55H	FFH	0	0	66H	DFH	02H	0
0012:	104H	22	IN A,DBB	55H	55H	0	0	66H		02H	0
0014:	105H	37	CPL A	55H	55H	0	0		DFH	02H	0
0016:	106H	02	OUT DBB,A	55H	55H	0	0	66H		00H	0
0018:	107H	8A03	MOV R2,#03H	55H	55H	0	0	66H	99H	00H	0
0022:	109H	8840	MOV R0,#.TABLE0	55H	55H	0	0	66H	99H	01H	0
0026:	10BH	8960	MOV R1,#.TABLE1	55H	55H	0	0	66H	99H	01H	0
.LOOP											
0030:	10DH	FD	MOV A,@RD	55H	55H	0	0		99H	01H	0
0032:	10EH	A1	MOV @R1,A	55H	55H	0	0	66H		01H	0
0034:	10FH	18	INC R0	55H	55H	0	0		99H	01H	0
0036:	110H	19	INC R1	55H	55H	0	0	66H		01H	0
0038:	111H	EA0D	DJNZ R2,.LOOP	55H	55H	0	0	66H	99H	01H	0
.LOOP											
0042:	10DH	FD	MOV A,@RD	55H	55H	0	0		99H	01H	0
0044:	10EH	A1	MOV @R1,A	55H	55H	0	0	66H		01H	0
0046:	10FH	18	INC R0	55H	55H	0	0		99H	01H	0
0048:	110H	19	INC R1	55H	55H	0	0	66H		01H	0
0050:	111H	EA0D	DJNZ R2,.LOOP	55H	55H	0	0	66H	99H	01H	0
.LOOP											
0054:	10DH	FD	MOV A,@RD	55H	55H	0	0		99H	01H	0
0056:	10EH	A1	MOV @R1,A	55H	55H	0	0	66H		01H	0
0058:	10FH	18	INC R0	55H	55H	0	0		99H	01H	0
0060:	110H	19	INC R1	55H	55H	0	0	66H		01H	0
0062:	111H	EA0D	DJNZ R2,.LOOP	55H	55H	0	0	66H	99H	01H	0
0066:	113H	00	NOP	55H	55H	0	0		99H	01H	0

user program and the state of the 8042 that is useful in debugging hardware and software. Changes can be made in memory and in the 8042 registers, flags, and port values. Commands are also provided for various utility operations such as loading and saving program files, defining symbols, displaying trace data, controlling system synchronization and returning control to ISIS-II. A summary of the basic interrogation and utility commands is shown in Table 3. Two additional time-saving emulator features are discussed below.

Single-Line Assembler/Disassembler

The single-line assembler/disassembler (ASM and DASM commands) permits the designer to examine and alter program memory using assembly language mnemonics, without leaving the emulator environment or requiring time-consuming program reassembly. When assembling new mnemonic instructions into program memory, previously defined symbolic references (from the original program assembly, or subsequently defined during the emulation session)

Table 3 Major Interrogation and Utility Commands

Command	Description
HELP	Displays help messages for ICE-42 emulator command-entry assistance.
LOAD	Loads user object program (8042 code) into user-program memory, and user symbols into ICE-42 emulator symbol table.
SAVE	Saves ICE-42 emulator symbol table and/or user object program in ISIS-II hexadecimal file.
LIST	Copies all emulator console input and output to ISIS-II file.
EXIT	Terminates ICE-42 emulator operation.
DEFINE	Defines ICE-42 emulator symbol or macro.
REMOVE	Removes ICE-42 emulator symbol or macro.
ASM	Assembles mnemonic instructions into user-program memory.
DASM	Disassembles and displays user-program memory contents.
Change/Display Commands	Change or display value of symbolic reference in ICE-42 emulator symbol table, contents of key-word references (including registers, I/O ports, and status flags), or memory references.
EVALUATE	Evaluates expression and displays resulting value.
MACRO	Displays ICE-42 macro or macros.
INTERRUPT	Displays contents for the Data Bus and timer interrupt registers.
SECONDS	Displays contents of emulation timer, in microseconds.
Trace Commands	Position trace buffer pointer and select format for trace display.
PRINT	Displays trace data pointed to by trace buffer pointer.
MODE	Sets or displays the emulation mode, 8041A or 8042.

Table 4 HELP Command

***HELP**
Help is available for the following items. Type HELP followed by the item name. The help items cannot be abbreviated. (For more information, type HELP HELP or HELP INFO.)

Emulation:	Trace Collection:	Misc:	<address>
GO GR SYD	TR QR QRD QRL SYL	BASE	<CPU#keyword>
BR BROBR1		DISABLE	<expr>
STEP	Trace Display:	ENABLE	<ICE42 #keyword>
	TRACE MOVE PRINT	ERROR	<identifier>
	OLDEST NEWEST	EVALUATE	<instruction>
		HELP	<masked#constant>
Change/	Display/ Define/ Remove:	INFO	<match#cond>
<CHANGE>	REMOVE CBYTE	<LIGHTS>	<numeric#constant>
<DISPLAY>	SYMBOL DBYTE DASM	LIST	<partition>
REGISTER	RESET ASM	LOAD	<string>
		MODE	
SECONDS	WRITE	SAVE	<string#constant>
DEFINE	STACK SY	SUFFIX	<symbolic#ref>
		SYMBOLIC	<mode>
Macro:	Compound		<trace#reference>
DEFINE DIR	Commands:		<unlimited#match#cond>
DISABLE ENABLE COUNT			<user#symbols>
INCLUDE PUT IF			
<MACRO#DISPLAY>	REPEAT		
<MACRO#INVOCATION>			

***HELP IF**
IF - The conditional command allows conditional execution of one or more commands based on the values of boolean conditions.

```

IF <expr> 'THEN <cr>          <true#list>::='<command> <cr> @
  <true#list>                  <false#list>;:='<command> <cr> @
  'ORIF <expr> <cr>          <command>::=An ICE-42 command.
  <true#list> @
  'ELSE <cr>
  <false#list>
END

```

The <expr>s are evaluated in order as 16-bit unsigned integers. If one is reached whose value has low-order bit 1 (TRUE), all commands in the <true#list> following that <expr> are then executed and all commands in the other <true#list>s and in the <false#list> are skipped. If all <expr>s have value with low-order bit 0 (FALSE), then all commands in all <true#list>s are skipped and, if ELSE is present, all commands in the <false#list> are executed.

```

(EX: IF .LOOP=5 THEN
  STEP
  ELSE
  GO
  END)

```

***EXIT**

may be used in the instruction operand field. The emulator supplies the absolute address or data values as stored in the emulator symbol table. These features eliminate user time spent translating to and from machine code and searching for absolute addresses, with a corresponding reduction in transcription errors.

HELP

The HELP file allows display of ICE-42 command syntax information at the Inteltec console. By typing "HELP", a listing of all items for which help messages are available is displayed. Typing "HELP <Item>" then displays relevant information about the item requested, including typical usage examples. Table 4 shows some sample HELP messages.

EMULATION ACCURACY

The speed and interface demands of a high-performance single-chip microcomputer require extremely accurate emulation, including full-speed, real-time operation with the full function of the microcomputer. The ICE-42 module achieves accurate emulation with an 8042 emulator chip, a special configuration of the 8042 microcomputer family, as its emulation processor.

Each of the 40 pins on the user plug is connected directly to the corresponding 8042 pin on the emulator chip. Thus the user system sees the emulator as an 8042 microcomputer at the 8042 socket. The resulting characteristics provide extremely accurate emulation of the 8042 including

speed, timing characteristics, load and drive values, and crystal operation. However, the emulator may draw more power from the user system than a standard 8042 family device.

Additional emulator processor pins provide signals such as internal address, data, clock, and control lines to the emulator buffer box. These signals let static RAM in the buffer box substitute for on-chip program ROM or EPROM. The emulator chip also gives the ICE module "back-door" access to internal chip operation, allowing the emulator to break and trace execution without interfering with the values on the user-system pins.



Figure 1 A Typical 8042 Development Configuration. The host system is an Inteltec Series IV. The ICE-42 module is connected to a user prototype system.

SPECIFICATIONS

ICE™-42 Operating Requirements

Inteltec Model 800, Series II, Series III, or Series IV Microcomputer Development SYstem (64K RAM required)

System console (Model 800 only)

Inteltec Diskette Operating System: ISIS (Version 3.4 or later).

Equipment Supplied

- Printed circuit boards (2)
- Emulation buffer box, Inteltec interface cables, and user-interface cable with 8042 emulation processor

- Crystal power accessory
- Operating instructions manuals
- Diskette-based ICE-42 software (single and double density)

Emulation Clock

User's system clock (up to 12MHz) or ICE-42 crystal power accessory (12 MHz)

Environmental Characteristics

Operating Temperature — 0° to 40°C

Operating Humidity — Up to 95% relative humidity without condensation.

Physical Characteristics**Printed Circuit Boards**

Width: 12.00 in. (30.48 cm)

Height: 6.75 in. (17.15 cm)

Depth: 0.50 in. (1.27 cm)

Buffer Box

Width: 8.00 in. (20.32 cm)

Length: 12.00 in. (30.48 cm)

Depth: 1.75 in. (4.44 cm)

Weight: 4.0 lb. (1.81 kg)

Electrical Characteristics**DC Power Requirements
(from Inteltec® system)** $V_{CC} = +5V, \pm 5\%$ $I_{CC} = 13.2A \text{ max}; 11.0A \text{ typical}$ $V_{DD} = +12V, \pm 5\%$ $I_{DD} = 0.1A \text{ max}; 0.05A \text{ typical}$ $V_{BB} = -10V, \pm 5\%$ $I_{BB} = 0.05A \text{ max}; 0.01A \text{ typical}$ **User plug characteristics at 8042 socket —**

Same as 8042 or 8742 except that the user system sees an added load of 25 pF capacitance and 50 μA leakage from the ICE-42 emulator user plug at ports 1, 2, T0, and T1.

ORDERING INFORMATION**Part Number Description**

ICE-42	8042 Microcontroller In-Circuit Emulator, cable assembly and interactive diskette software
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